



Laser Cleaning and Coatings Removal

SERDP Thrust Area: Pollution Prevention

Problem Statement:

New, automated aircraft paint removal systems are currently being developed to depaint or strip aircraft metallic and composite structures. However, these systems do not have the capability to efficiently and safely remove paint and other coatings from aircraft radomes and other components. Aircraft radomes must conform to stringent performance criteria to ensure accurate initial launch coordinates for missiles, artillery, and safe terrain avoidance/mapping information. Depot radome repairs consists of removing or "stripping" multi-layer dielectric coatings, filling and smoothing voids in the radome wall, and then applying new dielectric coatings onto the radome surface. Currently, there are four different coating systems that are applied to the radomes. These coating systems must be removed for depot inspection and repair. Today, the coatings are manually removed using hazardous chemicals which expose workers to potentially unsafe practices. The stripping procedure is performed in a paint booth with personnel using air supplied respirators. Workers must also wear protective equipment such as goggles, gloves and coveralls. During the stripping of the radome dielectric coatings, solvents are released to the atmosphere and toxic hazardous waste (contaminated paint residue and rags) is generated creating disposal problems. These practices must be discontinued as soon as possible to achieve DoD and Air Force Pollution Prevention goals. An automated system using laser, or other stripping technologies is required to remove personnel from this hazardous process and conform to local, state, and federal pollution prevention laws.

The goal of the proposed effort is to provide a field demonstration of a prototype laser-based facility to demonstrate environmentally acceptable component cleaning and coating removal technology and to transition it to the Air Force Logistic Centers and other aerospace users.

Targeted departments and organizations include:

- Oklahoma City Air Logistics Center (OC-ALC),
- San Antonio Air Logistics Center (SA-ALC),
- Warner Robbins Air Logistics Center (WR-ALC),
- Sacramento Air Logistics Center (SM-ALC), and
- Ogden Air Logistics Center (OO-ALC).

Cleaning and coatings removal technologies have traditionally depended upon the use of organic solutions, such as:

- PD 680 (I, II, & III) methyl ethyl ketone (MEK),
- methylene chloride (MECL),

- phenol, and
- strong acids and bases, as well as hot potassium permanganate solutions.

These materials are hazardous, and include volatile organic compounds (VOCs), ozone depleting chemicals (ODCs) and air toxic emitters which are subject to severe restrictions or are being banned altogether, such as freon (CFC-113). More recently, the trend in cleaning technology is toward the use of water-based cleaners (sodium metasilicate, bases, terpene/water emulsions or water detergent blends), some of which may be hazardous to some degree. However, technologies are needed which do not involve generation of waste water streams.

This is a new program. Laser-based cleaning and coating removal has been demonstrated to be an environmentally acceptable, affordable and controllable technology. A demonstration facility is needed to facilitate transition of this technology to Air Force, DoD and industry use, targeted to the immediate needs of the Air Logistics Centers.

Project Description:

The project objective is to demonstrate the use of laser cleaning and coating removal on components ranging from turbine engine blades to landing gear and radomes.

The project approach is to design, fabricate test, evaluate and demonstrate a state-of-the-art automated, controllable laser cleaning and coating removal facility. The facility will be designed for carbon dioxide and eximer laser cleaning and coating removal operations. System operation will be fully robotized and computer controlled with on-line instrumentation for component positioning and measuring and controlling laser inputs to the part surfaces.

Tasks associated with this project include:

- a. Design system to demonstrate technology on fighter aircraft landing gear and radome components.
- b. Design a subsystem system to handle, treat or capture, as necessary, all gaseous and particulate products of the process.
- c. Purchase or fabricate lasers, computers, robotics, controller, sensors, hardware and software necessary for the operation of the system.
- d. Assemble the demonstration facility system. Make necessary mechanical hardware and software modifications to insure safe, reliable and controllable operations.
- e. Demonstrate system on both metallic and non-metallic specimens.
- f. Test and evaluate adequacy of cleaning and coating removal process for aircraft components.
- g. Operate the facility and make it available for ALC and GOCO engineering evaluation on specific aircraft components. Qualify facility to applicable specifications for aircraft components cleaning and coating removal.

The proposed effort responds to pollution prevention mandates by DoD and the Air Force. The effort also will enable reduction of risks, compliance costs and liabilities associated with use and release of toxics to the environment. This program supports the DoD objectives to reduce volatile air emissions by 50% by the end of 1999 (1993 baseline).

Extensive test and evaluation work has been completed by the Air Force and the Navy on laser radiation effects on substrate materials and coating removals. What is needed next is a prototype facility where test and evaluation cost analysis and cleanliness levels can be performed on a variety of aircraft components. The facility would be available to the services as well as the aerospace community for test and evaluation purposes.

The technical risks involved in this project are low. Industrial lasers, both carbon dioxide and eximer are available; controls, robotics sensors, instrumentation are also available. Software will have to be developed/modified to control the production system. Systems design must incorporate all applicable safety devices and features.

Expected Payoff:

The laser-based cleaning and coating removal facility will be applicable to a broad range of aircraft and general equipment cleaning and coatings removal work. Benefits include the complete elimination of the use of toxics and hazardous waste generation in logistic center maintenance and re-manufacturing operations relying on the new technology. The limits of such potential payoffs are presently unexplored and remain to be determined. The process is expected to be highly cost effective considering that all costs for hazardous materials management and management of solid, liquid, and vapor waste streams will be eliminated.

Milestones:

Date	Description
FY93	
Jul	Project Initiation/start
Jul	Initiate preliminary systems requirements study
Sep	Complete preliminary systems requirements study
FY94	
Dec	Complete detailed systems analysis design
Dec	Initiate design review process
Mar	Approve Design
Mar	Initiate hardware procurement/component fabrication
May	Initiate life cycle cost study
Aug	Initiate systems assembly and check-out operations
FY95	
Aug	Complete life cycle cost studies and economic benefit studies
Sep	Final report and transfer of system to selected ALC
Oct	Complete check-out and de-bug of system operations
Dec	Initiate test and evaluation with services and industry customers

Transition Plan:

It is planned that the system to be built under this effort will be a prototype demonstration and as such will have many more capabilities than required on an actual production system. Users will perform test and evaluation programs on the prototype and determine the capabilities needed for their production unit. Cost data will be generated, specific engineering problems will be addressed and production systems design requirements will be generated.

Funding: (\$K)

- FY93: 350
- FY94: 2000

Performers:

The project will be performed under the technical leadership and direction of the following:

Air Force Materiel Command
Aeronautical Systems Center
Wright Laboratory
Materials Directorate
Wright-Patterson AFB, OH 45433

The Materials Directorate will award one or more research contracts to industry to perform the development and integration.

In order to facilitate generation of public domain information, hands-on government technology assessment and technology transition, the Materials Directorate plans on having the demonstration site to be either an Air Force Materiel Command Air Logistics Center or the Developmental Manufacturing and Modification Facility (DMMF) at Wright Patterson AFB Ohio.

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